AOIT Computer Networking

Lesson 2

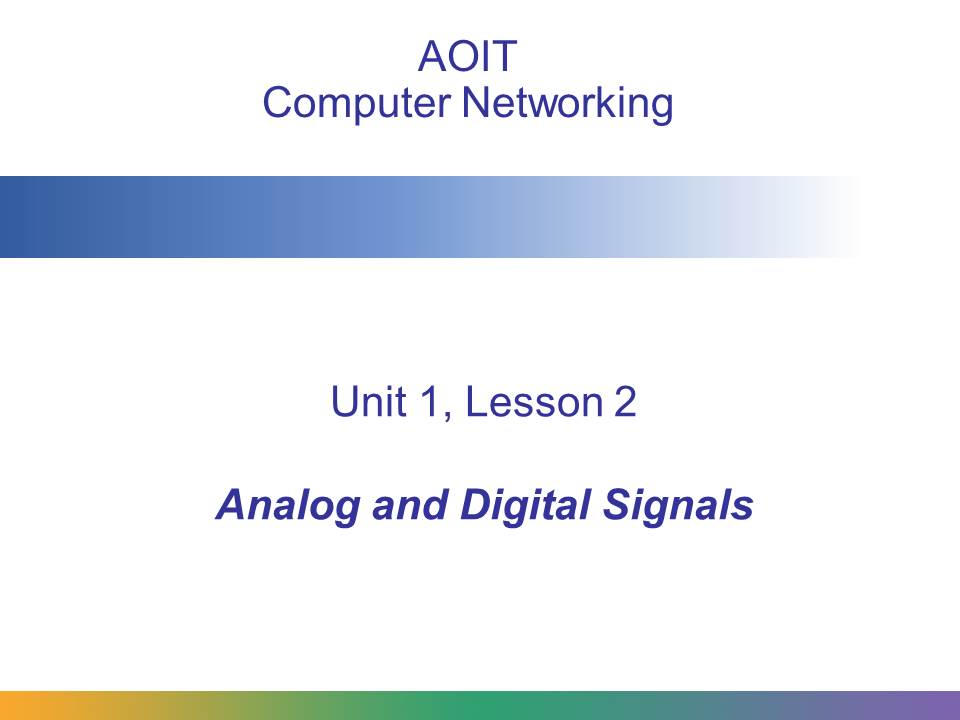
Introduction to Networking

Student Resources

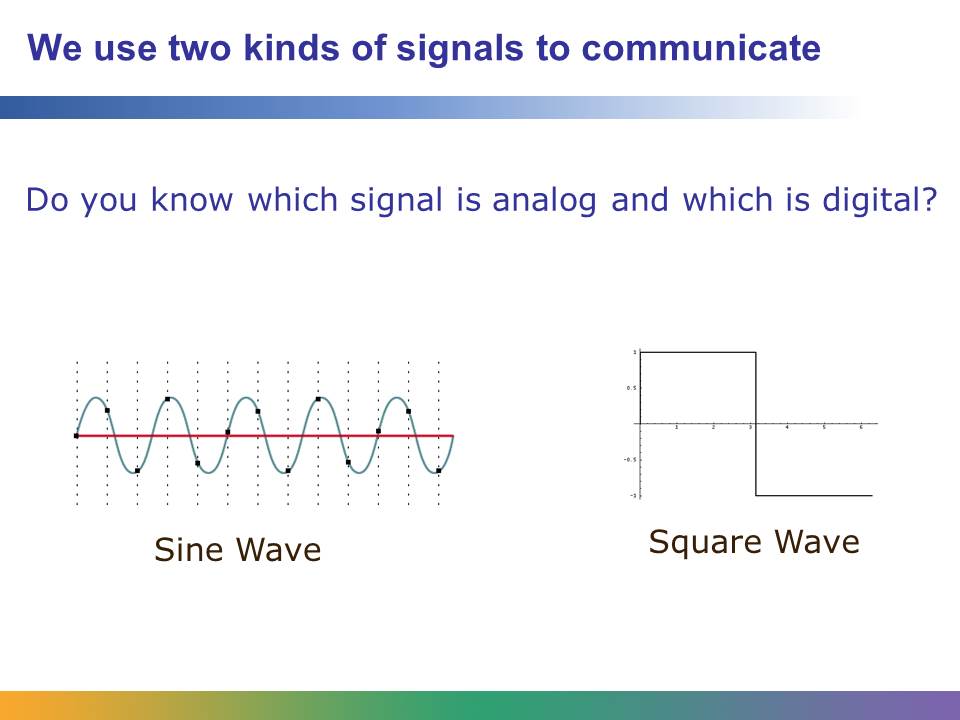
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Student Resource 2.1

Reading: Analog and Digital Signals

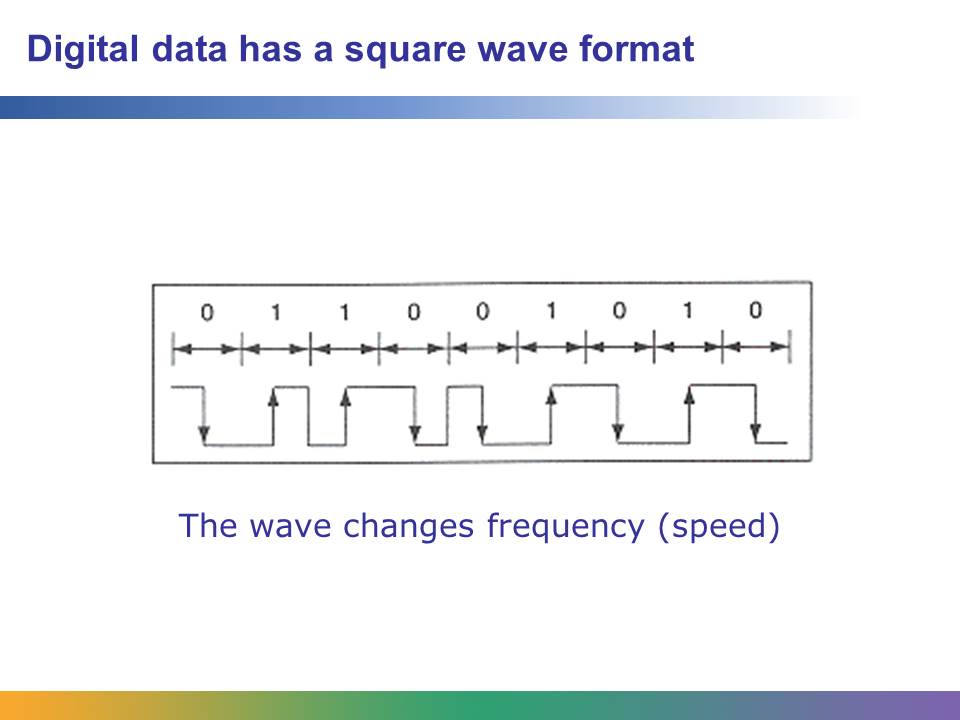


This presentation describes the physical qualities of analog and digital signals and how those signals are used in communications networks.



Do you know which is the analog and which is the digital signal?

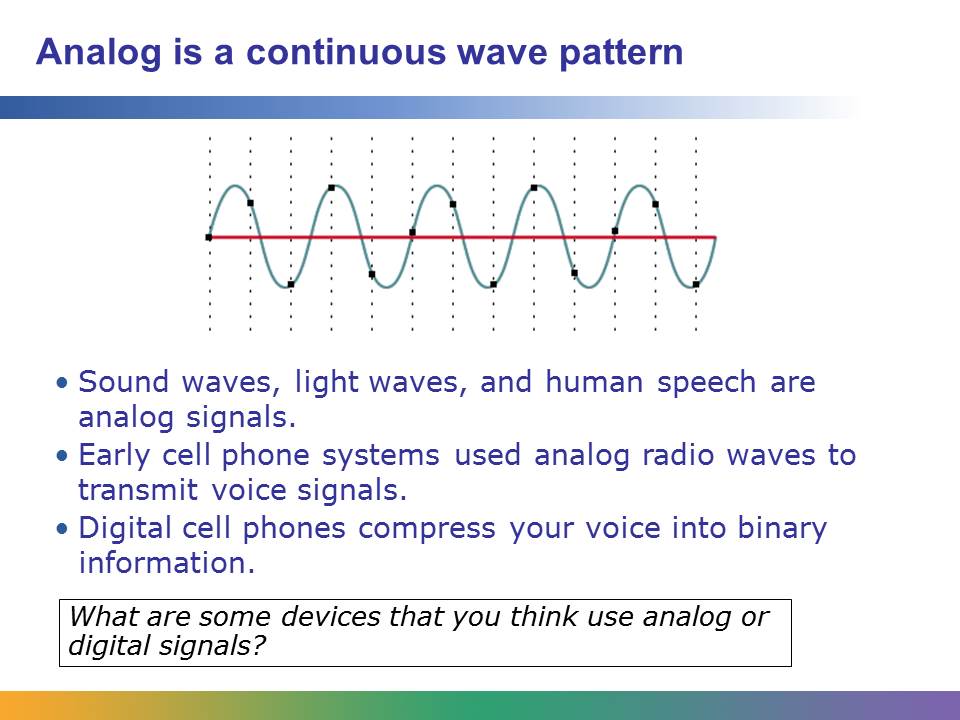
Here’s a clue to help you think about the differences between the two types of signals: an analog signal is continuous; a digital signal is either on or off.



This graph shows the square waveforms used by digital networks. The ups and downs in the waveform show changes in frequency. Can you see how the spacing between the high and low spots is different as the wave travels from left to right? This shows how the frequency changes over time and how this might be interpreted into binary: one or zero, on or off. Electronics detect a 0 if there is a down-going transition in the clock timing window and a 1 if there is an up-going transition in the clock timing window.

Computer systems use binary code to communicate. Ones and zeros are strung together to form instructions to the computer. Computer networks use electric pulses across wire to communicate. The pulses travel with less static and interference than analog signals, which tend to degrade more across longer distances.

In and of itself, a digital signal means nothing, but we can assign different meanings to it. We just need to make sure that the computers reading the signal know how to properly interpret it.



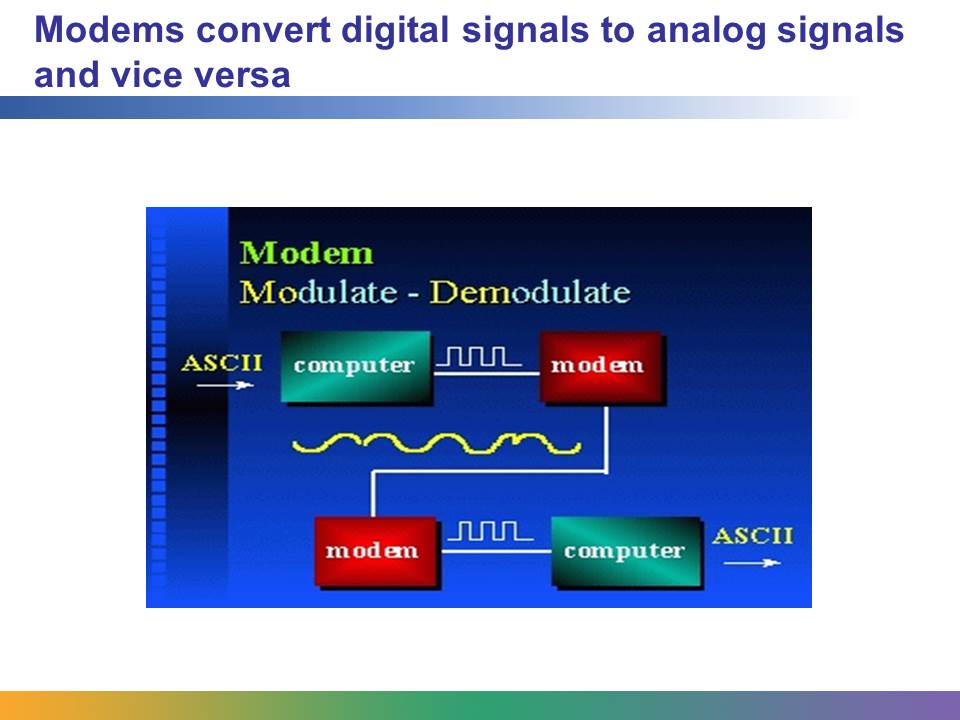
The sound of the human voice is an example of an analog signal. So, what makes it different from a digital signal?

An analog signal is a wave pattern that is continuously variable.

In the world around us, all sounds are actually analog sounds. Everything we perceive has a gradual change over time. Examples of analog signals include sound and light waves. Audio tape cassettes are analog; CDs and DVDs are digital.

Early cell phone systems used analog radio waves to transmit voice signals, so they were analog.

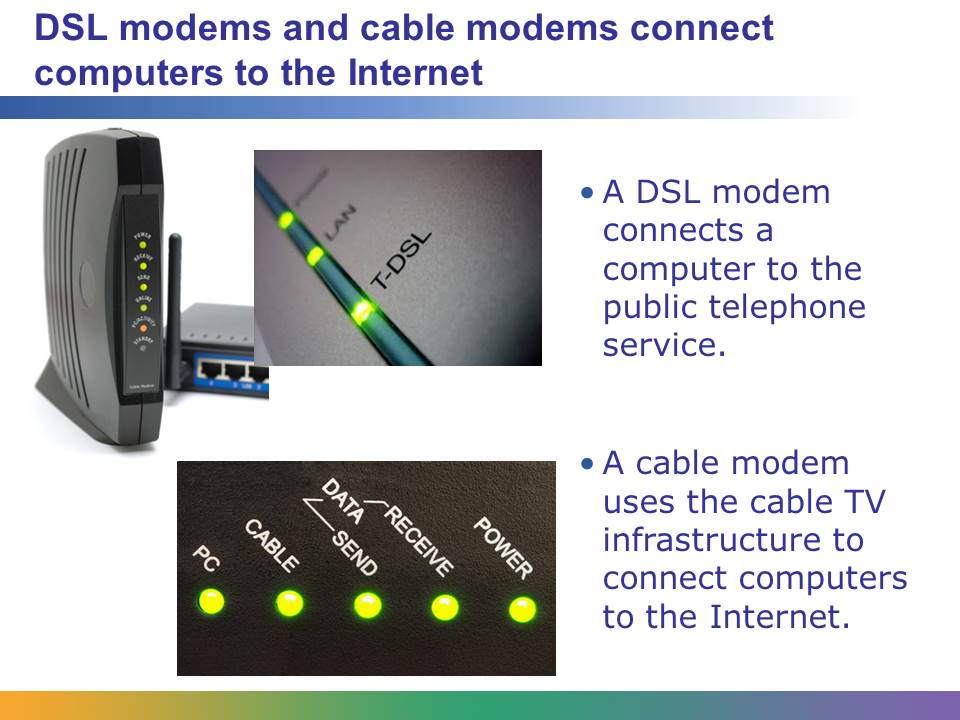
Second-generation (2G) and later cell phones are digital. They use the same radio technology as the early analog cell phones, but the digital signal is compressed in a way that analog signals cannot be. Digital cell phones compress your voice into binary information. Because they can be compressed, digital signals allow more channels to fit in a given bandwidth.



Modems are used to connect computers to the Internet via analog phone lines. The word *modem* is short for MOdulate and DEModulate, because this is what a modem must do in order to connect the digital to an analog signal.

When a user connects to the Internet on a telephone wire, the binary code is modulated and transformed to an analog one via a modem; it is then demodulated—or translated back to binary—at the other end.

ASCII is the system we use to translate the alphabets we type on a computer into the computer’s native binary language. Our full, rich alphabets of 26 letters, 10 numbers, and all the other symbols we use (such as punctuation) are too complicated for the computer, since the computer uses only electric pulses to communicate. So, ASCII translates the symbols into something the computer can understand within its binary structure.



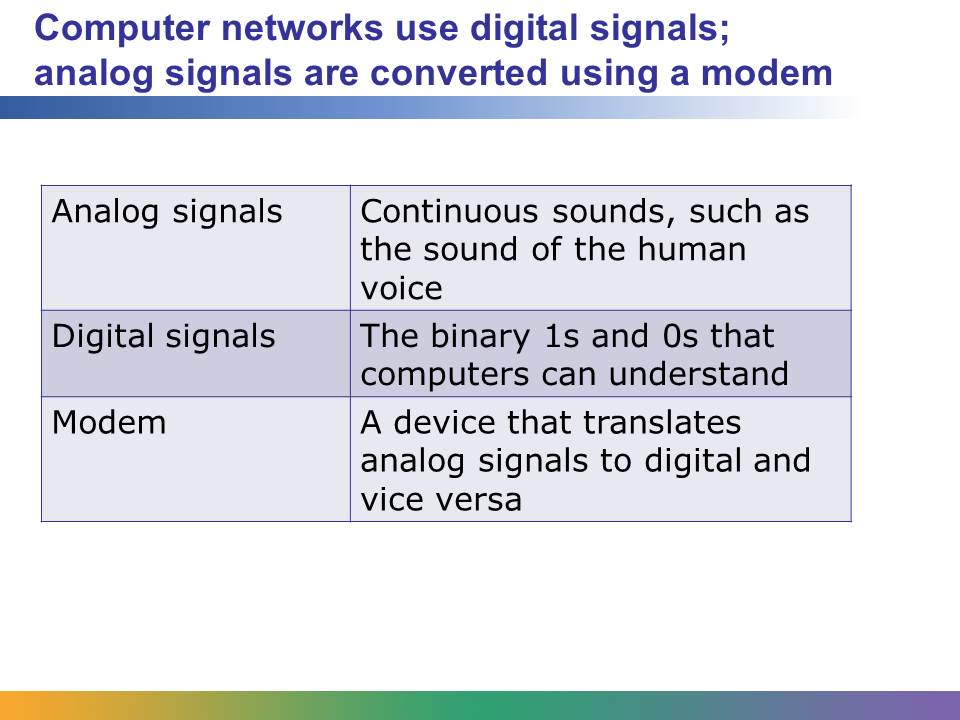
The first computer networks relied on analog telephone lines to connect. Since the computer spoke in binary but the phone lines used only analog signals, the computer was connected to a modem, which translated the message into an analog signal. On the other end, the analog signal coming from the telephone line was converted back to a digital one so that the other computer could read it.

Today, most people use cable or DSL—digital lines—to connect to the Internet, which is a purely digital network.

DSL service uses a DSL modem to connect your computer to your public telephone service.

Cable service uses the cable TV infrastructure to bring an Internet connection to your home, school, or office. Cable companies that provide Internet service require you to use a cable modem to connect your computer to the Internet.

Some Internet service providers offer voice over Internet Protocol (VoIP) technology, which uses a modem that separates voice information from data. With VoIP, you don’t need a land line. Some telephone companies do not offer DSL service without telephone line service, although more companies are beginning to unbundle their DSL and phone services. Currently, VoIP is more popular with cable modem users.



As you learn more about computer networks, you will build on everything that you have learned about analog and digital signals.

Student Resource 2.2

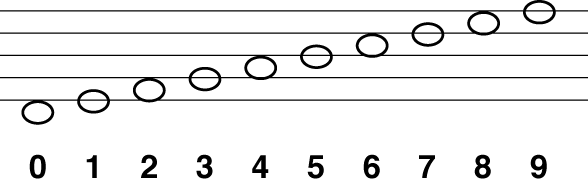
Worksheet: Creating Analog Signals

Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_

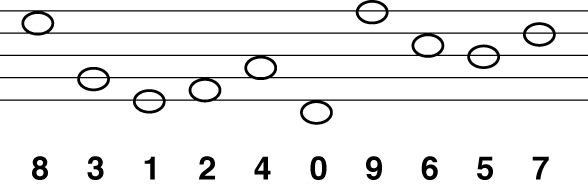
Directions: Create your own analog signal using the following analog code. Each number is represented by a symbol that is similar to a musical scale. On the blank scales below, translate your phone number (the outgoing number) and the phone number of someone you call often, such as a friend (the incoming number), into this musical code. An example is provided. When you are done, give your paper to your partner to interpret. Your partner will write the translated number below the notes, as in the example.

Analog signals can use different pitches, or tones, to communicate messages. For example, when you make a phone call, you can hear that each number has its own musical tone, or a different pitch from the other numbers. These tones tell the phone company what number you are trying to dial. When you dial a call, you do so by number—but the phone doesn’t understand the numbers, just the tones. So, it’s really listening to the tonal signal it receives and it uses that signal to make the call.

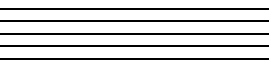
Musical Code



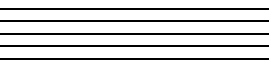
Example Phone Number



Outgoing Number



Incoming Number



Student Resource 2.3

Worksheet: Creating Digital Signals

Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_

Directions: Morse code is a digital alphabet that was created for transmitting electrical signals over the telegraph. The amount of electricity, or volts, going over the wire is always the same, but the length of time the electricity lasts can change. Operators use an alphabet of dots and dashes, also known as dits and dahs, to write messages. Dots are short sounds, and dashes are long sounds.

Using Morse code, create your own digital signal for your partner to interpret. In the space provided, translate the full name of someone you know into Morse code, such as the name of your best friend, grandmother, or cousin. Remember to leave spaces between each letter, and write the code for a full stop at the end of the message. When you are done, give your paper to your partner to interpret.

Remember that digital signals are binary, which means they have two states: they can be either on or off. The length of time the signal is on indicates its meaning.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| The Morse Code Alphabet | | | | |
| A **.-**  B **-...**  C **-.-.**  D **-..**  E **.**  F **..-.**  G **--.**  H **....** | I **..**  J **.---**  K **-.-**  L **.-..**  M **--**  N **-.**  O **---**  P **.--.** | Q **--.-**  R **.-.**  S **...**  T **-**  U **..-**  V **...-**  W **.--**  X **-..-** | Y **-.—**  Z **--..**  0 **-----**  1 **.----**  2 **..---**  3 **...—**  4 **....-**  5 **.....** | 6 **-....**  7 **--...**  8 **---..**  9 **----.**  Full stop **.-.-.-**  Comma **--..--**  Query **..--..** |

Someone’s name in Morse code:

Translation into English:

Student Resource 2.4

Reading: How Data Travels on a Computer Network

Directions: This reading explains how computer networks send data from computer to computer using packets. While you are reading, highlight the information you want to include in an illustration that shows what a packet-switching network looks like. This will prepare you to illustrate a network on Student Resource 2.5, Illustration: Packet-Switching Network.

Packet-Switching Technology Moves Data across a Network

You might define a *packet* as some kind of package or parcel, something that can be bundled and sent through the US Post Office to a friend. A digital packet is similar.

When computers send information across a network, they first break the information into small parcels called packets. Each packet is labeled with address information that identifies the sending computer and the intended recipient. Network switches and routers use these addresses to figure out the best route to keep the packet moving on the path to its destination. Each packet travels separately across the network, and then when all of the packets arrive at the destination, they are regrouped in the correct order. The address contains information about which order the packets go in so that the computer that receives the packets can reassemble them.

This process is called *packet switching,* becausepackets are switched from one router to the next along the network until they reach their final destination.By sending packets through many computers instead of along a set line, the network can also be expanded by simply adding more computers. If one computer crashes, it doesn’t matter, and communications can continue along their route using the other computers.

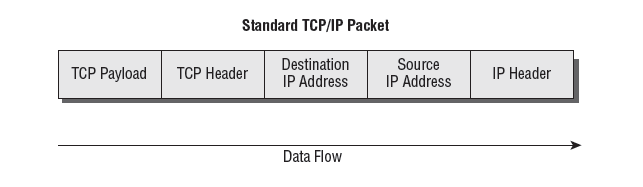
TCP and IP Set Rule for How Packets Travel

TCP and IP are communication protocols. A *protocol* is a set of rules that regulate how something works. IP, which stands for *Internet Protocol,* breaks data into packets and gives each packet a sequence number. This makes it possible to deliver packets across multiple routes, depending on which route is the fastest at any given moment. The receiving system gets information about the total number of packets and what sequence they should go in.

All IP packets have a header that contains information such as the total number of packets and what sequence they should go in. The part of the packet that is the actual data is sometimes called a *payload*.

Network congestion or other unpredictable network behavior can sometimes cause IP packets to be lost, duplicated, or delivered out of order. If any part of the connection breaks or becomes slowed down by other network traffic, packets can simply be delivered along other routes. TCP, which stands for *Transmission Control Protocol*, controls how data is sent. TCP detects any transmission problems, requests retransmission of lost data, rearranges out-of-order data, and even helps minimize network congestion to reduce the occurrence of the other problems.

A typical standard TCP/IP packet might be structured like the following diagram:



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Transmitting Voice

Historically, IP networks weren’t very good for voice communications such as telephone calls, because any lag time in the network would cause a loss in voice quality. If one packet arrived later than the one before it, it was too late and had to be dropped. Recently, standards have changed to give priority to voice packets so that they go through the network more quickly than data packets. The technology that allows transmission of voice calls over packet-switched networks is called voice over IP (VoIP). As networks become faster, telephone calls over the Internet are becoming more and more popular.

Student Resource 2.5

Illustration: Packet-Switching Network

Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_

Directions: In the space below, draw a picture or a series of pictures that illustrate how a packet-switching network works. Base your drawing on what you learned in the reading (Student Resource 2.4). When you have completed your illustration, it will serve as a reference for the quiz at the end of the lesson.

Include the following in your illustration:

|  |  |  |
| --- | --- | --- |
| Originating computer  Destination  Data packets | Composition of a packet  Routers | What is Internet Protocol (IP) doing?  What is Transmission Control Protocol (TCP) doing? |